Metallic glass could make your next cell phone harder to break

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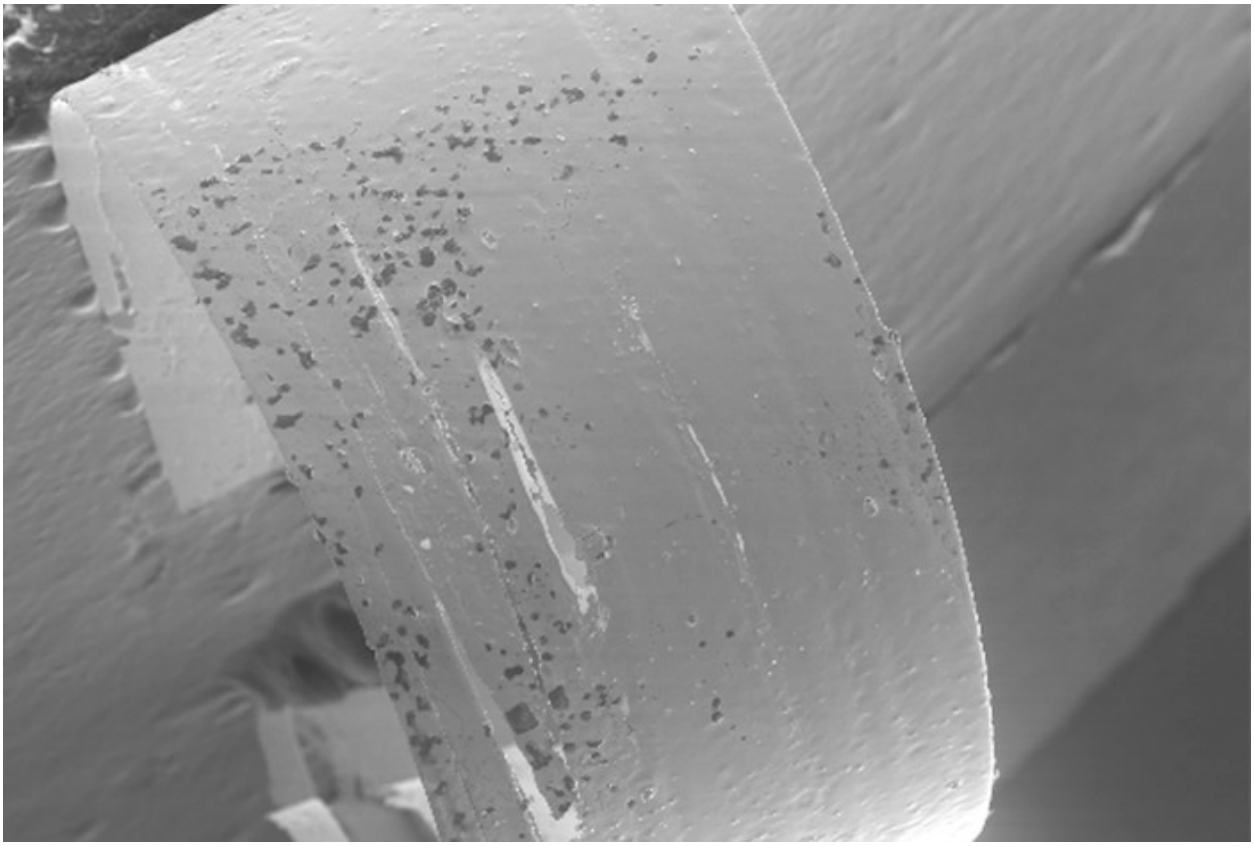

Metal and glass objects are all around us but Seth Imhoff, with the Lab's Metallurgy group, is working to better understand how to manipulate the molecular structures of metals to give them more glass-like qualities. With more knowledge and the right processes, combining their various advantages could lead to materials with optimal characteristics for a host of applications, such as cellphone cases.

The atoms in a gas are spread out at relatively great distances and each atom moves randomly, changing direction whenever it bumps into something. A liquid behaves similarly except the atoms are closer together. If the atoms' movement were stopped, their pattern would be irregular or, in scientific terms, amorphous.

Glasses are solid but their structure is amorphous. In contrast, the atoms in a normal metal are very regular, or crystalline—unless that structure is manipulated as it transitions from molten to solid.

Picture a blacksmith making a sword back in the Middle Ages as he plunges a piece of heated steel into a vat of cold water. By quenching the steel in the water, a different and harder crystal structure is formed compared to just letting it cool on the bench. Metallic glasses are also usually formed by rapid cooling but instead of crystallizing, the atoms remain randomly arranged as in a liquid. A metal with an amorphous structure takes on new qualities and making small changes in the glassy metal's makeup and how its is cooled leads to even more variations in the end product.

While some metallic glass experiments have included the use of expensive elements, such as palladium, others use more common metals like aluminum. Interestingly, early uses of new materials (such as metallic glass) are for recreational purposes. Imhoff pointed out that sports are often early adopters of new materials technology because even the slightest advantage in things like strength, weight and durability can be worth a premium price if it increases performance.

As more is learned about how these various components interact with each other, metallic glasses can be developed with varying degrees of as strength, resilience, magnetism, electrical capacity and even corrosion resistance. Commercial applications for this technology already include electrical transformers and cellphone cases in addition to golf clubs.

The Lab partners with other institutions in its metallic glass research, including the University of Wisconsin-Madison, Universitat Autònoma de Barcelona in Spain, and Tohoku University in Japan. Funding for the research comes from the National Science Foundation; Office of Naval Research; Grants-in-Aid-S; Global COE for Materials Science; World Premier International Research Center Initiative for Atoms, Molecules and Materials; and Japan's Ministry of Education, Culture, Sports and Science.

To view a brief, 22-second YouTube video that demonstrates the dramatic difference in response to a ball bearing being dropped on metallic glass (left) versus on stainless steel (right), go here.

To read a paper on the subject recently published in the *Proceedings of the National Academy of Sciences of the United States*, go here.